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PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
SGS/50906		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/SG98/00022	20/03/1998	20/03/1998
International Patent Classification (IPC) or national classification and IPC H04N7/50		
Applicant SGS-THOMSON MICROELECTRONICS ASIA PAC. .... et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 13 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 9 sheets.

3. This report contains indications relating to the following items:

I	☒	Basis of the report
II	☐	Priority
III	☐	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	☒	Lack of unity of invention
V	☒	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
VI	☐	Certain documents cited
VII	☒	Certain defects in the international application
VIII	☒	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
14/10/1999	11.07.2000
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Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/SG98/00022

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1,7-15	as originally filed			
4	as received on	25/03/2000	with letter of	15/03/2000
2,3,5,6	as received on	24/06/2000	with letter of	17/06/2000

Claims, No.:

9 (part)	as received on	25/03/2000	with letter of	15/03/2000
1-8,9 (part)	as received on	24/06/2000	with letter of	17/06/2000

Drawings, sheets:

1-5	as originally filed

2. The amendments have resulted in the cancellation of:

☐ the description, pages:
☒ the claims, Nos.: 10-25
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

☐ restricted the claims.

☐ paid additional fees.

☐ paid additional fees under protest.

☐ neither restricted nor paid additional fees.

2. ☒ This Authority found that the requirement of unity of invention is not complied and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

☐ complied with.

☒ not complied with for the following reasons:

see separate sheet

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

☒ all parts.

☐ the parts relating to claims Nos. .

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-9
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-9
Industrial applicability (IA)	Yes:	Claims	1-9
	No:	Claims	

2. Citations and explanations

see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

1. General

The following document is cited:
D1: EP-A-0 804 035.

The present application does not satisfy the criteria set forth in Articles 6 and 33(3) and Rule 13 PCT. Details of the objections are set out below.

2. Concerning Section VIII - Art. 6 PCT:

The claims fail to meet the requirements of Article 6 PCT, for the reasons set out in the following. Accordingly, the claims require amendment to remove this defect.

2.1.

The various definitions of the invention given in independent apparatus claims 8 and 9 are such that the claims as a whole are not concise, contrary to Art. 6 and Rule 6.1(a) PCT. Thus lack of clarity of the claims as a whole arises, since the plurality of independent apparatus claims makes it difficult, if not impossible, to determine the matter for which protection is sought, and places an undue burden on others seeking to establish the extent of the protection. Hence, the claims do not meet the requirements of Article 6 PCT.

2.2. Claim 1

Claim 1 (feature a)) refers to determining an "overall target bit rate for encoding the sequence of images; and for each segment in the sequence of images". This wording implies a same target bit rate for both the entire sequence and for each segment therein (a segment eg being represented by a GOP or a picture therein). The feature does not at present define plural

target bit rates respectively for the sequence and each segment.

According to the description on the one hand (p.14 lines 7-10) a target overall bit rate (overall_BR) 320 is defined for a sequence of pictures including plural segments, and on the other hand (p.19 lines 4-10) a target segment bit rate (segment_BR) 406 different from the target overall bit rate is determined.

The claim's scope of protection is obscured by its discrepancy with the description, thus claim 1 contravenes Art. 6 PCT.

The claim further fails to clearly specify which segments are meant by "a next k segments" (p.26 lines 11-12). This is because a term such as "a current segment" is missing in the claim so that the relationship between "preceding" and "next" segments is not well-defined.

The claim's scope of protection is further obscured by its feature d)(p.26 lines 14-15) specifying "calculating ... from the bits distribution and a predetermined number of images in the segment" which is in clear contrast to the description stating "... from the bits distribution and the number of pictures in the current segment to be coded".

These and other deficiencies of claim 1 with respect to clarity will become apparent from the following redrafted version of claim 1 that is considered to meet the requirements set out in Art. 6 PCT (changes emphasized, based on pages 14, 19-20 and Figs. 4 and 5):

"A method for controlling ... including:

a) determining **a target overall** bit rate **(overall_BR)** for encoding the sequence of **segments**, and **a target bit rate (segment_BR)** for each segment;

b) **for a current segment** determining **(401)** a difference of bits **(bits_diff)** between a number of bits used for encoding at least one **segment preceding the current segment** and a number

of bits allocated for encoding the at least one preceding segment;

c) calculating **(402)** a bits distribution from the determined bits difference and a predetermined distribution function **(f(m))** for redistributing said difference of bits **over next** k segments **following said at least one preceding segment**, where k is a positive integer;

d) calculating **(403)** a bit rate change **(delta_segment_BR)** from the bits distribution and **the** number of images in the current segment;

e) calculating **(405)** a target segment bit rate **(segment_BR) for the current segment** from the bit rate change and said overall target bit rate for the sequence of images; and

f) determining **(407)** a target segment encoding quality **(target_Q) for the current segment** from the target segment bit rate."

2.3. Claims 2, 3, 5, 6

Claims 2, 3, 5 and 6 are currently obscured by a misarrangement of formulas.

The formula currently being appended to claim 2 should correctly be positioned after line 4 of claim 3, as in the claims' previous version.

Likewise, the formula currently being appended to claim 5 should correctly be positioned after line 2 of claim 6, as in the claims' previous version.

2.4. Claim 8

The objections raised against claim 1 correspondingly apply to claim 8.

For the applicants convenience, a corresponding version of the claim including changes that would make the claim compliant with the requirements set out in Art. 6 PCT and provide a match with claim 1 is provided:

"An encoding quality adjustment processor ..., comprising:

- a bits difference computation means coupled to receive a segment encoding utilisation value (bits_segment) and a target segment bit rate **(segment_BR)** and generate **(401)** therefrom a bits difference value **(bits_diff)** representing **the** difference in bits allocated and bits used for encoding **at least one** segment **preceding a current segment**;

- a bits distribution means coupled to the bits difference computation means for computing **(402)** at least one bits distribution value **(delta_bits)** from the determined bits difference value and a predetermined distribution function **(f(m))** for redistributing the difference in bits allocated and bits used for encoding **said at least one** segment **over next** k segments **following said at least one preceding segment**, where k is a positive integer;

- a bit rate difference computation means coupled to the bits distribution means for computing **(403)** a segment bit rate **change (delta_segment_BR)** from the at least one bits distribution value and **the** number of images in the current segment;

- a target segment bit rate adjustment means coupled to the bit rate difference computation means and the bits difference computation means for computing **(405) a** target segment bit rate **(segment_BR) for the current segment** from the segment bit rate **change** and a predetermined target overall bit rate **(overall_BR)** for the sequence of segments; and

- an encoding quality computation means **(309)** coupled to the target segment bit rate adjustment means for computing **(407)** a target segment encoding quality **(target_Q) for the current segment** from said target segment bit rate."

2.5. Claim 9

The substance of the objections raised above against claim 1 with respect to Art. 6 PCT at least partly apply to claim 9. Moreover, claim 9 suffers from further deficiencies with respect to clarity which will become apparent from the analysis of the claim in paragraph 3 below.

3. Concerning Section IV (Rule 13.1 PCT/Unity)

As far as the subject-matter of independent claims 1 and 8 can at present be construed, they appear to be linked by a common technical concept:

(a) adaptive determination of target encoding parameters for individual segments each including at least one image of a sequence of images,
(b) wherein a current segment is encoded according to target encoding parameters that take into account the difference in the number of bits used for encoding preceding segments and the number of bits allocated therefor,
(c) and wherein the difference is distributed to one or more next segments following the preceding segments (thus including the current segment) according to a predetermined distribution function.

In comparison thereto, claim 9 appears to effectively specify:

(a') determining the number of bits used for encoding successive pictures in a segment (that is a group of pictures), the determining being effected by tracking bits used for encoding successive macro blocks;
(b') adaptive determination of a quantisation step size to be used in the coding of macro blocks (this step size to be applied on a macro block basis is substantially different from

- the "target segment encoding quality" addressed in claims 1 and 8) from a target number of bits allocated for a picture (this is different from the segment-based target number provided in claims 1 and 8)
- and the number of the number of bits already used for encoding the picture;

(c') determining a target number of bits allocated for a picture (presumably for a current one to be encoded) from

- a target bit rate (for the picture?)
- and the number of bits already used in a current group of pictures (ie in a current segment);

(d') determining (updating?) said target bit rate (for the picture?) from

- the number of bits already used for encoding successive pictures in the current group of pictures (ie in a current segment),
- a target encoding quantisation step size (presumable for the current segment?),
- and an average quantisation step size for pictures in the current group of pictures (ie in the current segment);

(e') determining said target encoding quantisation step size from

- a predetermined target overall bit rate
- and the number of bits used for encoding a preceding group of pictures.

In summary, most of the features of claim 9 appear to pertain to determining encoding parameters for a current picture in a current segment based on the number of bits already used in encoding the current segment. Only the claim's last feature (identified above as (e')) appears to address determining an encoding parameter of a current segment based on the number of bits used in a preceding segment.

Accordingly, claim 9 and the one hand and claims 1 and 8 on the

other hand appear to be linked by the concept of adaptively changing encoding parameters (including target numbers of bits allocated for encoding) for a portion of image data (eg a picture or a segment) in a sequence of images, wherein the changes are based on the number of bits already used in encoding.

Such a concept is well-known in the art, cf eg D1 (abstract; Figs. 6-14; p.2 line 58 - p.4 line 38). Even if D1 should be interpreted as merely relating to parameter control on a macro block basis (in contrast to the present independent claims pertaining to control on a picture or segment basis), such an extension from segments representing a macro block to segments presenting a group of pictures is considered a straightforward design option readily available to the skilled person without exercise of an inventive step. Reference is made in this context to D1: p.8 lines 43-50.

In light of the above, it is not at present possible to identify subject-matter in claims 1 and 8 on the one side and claim 9 on the other side on which a common and inventive concept as required by Rule 13.1 PCT could be based.

Accordingly, it is considered that the application lacks unity (Rule 13.1 PCT contravened) and comprises two groups of inventions:
Group I : claims 1-8;
Group II: claim 9.

4. Concerning Section V (Articles 33(2), (3) PCT)

Despite the independent claims' deficiencies with respect to clarity (Art. 6 PCT), novelty of the claimed subject-matter can be attributed in comparison to the disclosure of D1.

As to inventive step, the following passages of D1 are referred to:

- abstract;
- p. 2 line 11 to p. 4 line 12 referring to background art;
- p. 4 lines 15-38;
- p.8 lines 30-50;
- Figs. 3-5, 9-11, 14-16 and the related text passages.

The skilled person attempting to routinely modify the design provided by D1 while taking account of the suggestions for variations made therein (eg p.8 lines 43-50) would arrive at the subject-matter of any of claims 1, 8 and 9 without exercise of an inventive step. It is stressed that even the concept provided by claims 1 and 8 relating to enabling distribution of the determined bit number difference resulting from the encoding of a preceding segment or preceding segments to plural ones of following segments including a current segment is considered to be anticipated by D1 (Figs. 9-11).

Accordingly, claims 1, 8 and 9 (as far as the latter's subject-matter can at present be construed) contravene Art. 33(3) PCT.

The additional subject-matter of the dependent claims is also considered as not being capable of establishing an inventive step. This is because the methods provided therein appear to be nothing more than straightforward design implementations readily available when implementing and routinely modifying the design disclosed by D1.

5. Concerning Section VII: Description and other belongings

The claims are not cast in the two-part form as required by Rule 6.3(b) PCT.

In the present case it is considered extremely important and

also feasible to complement the claimed features with reference signs as required by Rule 6.2(b) PCT, which Rule is currently contravened.

A document reflecting the prior art described on pages 9 (line 25) to 13 (line 25) is not identified in the description (Rule 5.1(a)(ii) PCT).

Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the document D1 is not mentioned in the description, nor is this document identified therein.

visual quality. An example of a VBR encoder is described in United States patent number 5,650,860, entitled "Adaptive Quantization". In order to maintain a maximum bit rate allowed by the target storage device as well as an overall bit-rate which enables input picture sequence to be stored into a defined storage space, such VBR encoders utilise multiple encoding passes.

In the first encoding pass, the bit utilisation information is determined for each scene or each picture in the input sequence. This may be done by fixing the reference quantisation step size and disabling the VBV control. The determined bit utilisation information is then used to generate a bit budget for each scene or picture such that an overall target number of bits to code the sequence is fixed, and that the maximum bit rate is not violated. In cases that bit utilisation information obtained is not close to that required for generating the bit budget, steps from the first coding pass must be repeated with an adjusted reference quantisation step-size. The input sequence is coded in a final pass using the generated bit budget information to achieve the target bits or overall bit rate.

Multiple-pass VBR encoders requires large storage memory for intermediate bit utilisation information, and large computation needs for the additional passes and bit budget generation. Furthermore, such a VBR encoder cannot process input sequences in real-time as required by certain applications.

Summary of the Invention

In accordance with the present invention, there is provided a method for controlling bit allocation in a moving pictures encoder for encoding a sequence of images comprising a plurality of segments each including a number of images, the method including:

a) determining an overall target bit rate for encoding the sequence of images; and for each segment in the sequence of images:

b) determining a difference of bits between a number of bits used for encoding at least one preceding segment and a number of bits allocated for encoding the at least one preceding segment;

c) calculating a bits distribution from the determined bits difference and a predetermined distribution function for redistributing said difference of bits over a next

k segments, where *k* is a positive integer;

d) calculating a bit rate change from the bits distribution and a predetermined number of images in the segment;

e) calculating a target segment bit rate from the bit rate change and said overall target bit rate for the sequence of images; and

f) determining a target segment encoding quality from the target segment bit rate.

The advantageous effects of the present invention enable the provision of, for example:

a single-pass real-time variable bit rate encoder for moving pictures;

variable bit rate encoding of moving pictures such that the change in encoded picture quality from one scene to another is minimised; and

a real-time variable bit rate encoding algorithm which produces a constant overall bit rate.

In particular, embodiments of the present invention encode an input moving pictures sequence one segment at a time according to a target encoding quality which is determined by a target segment bit rate. The target segment bit rate of a current segment is preferably derived from the differences between the target segment bit rates and the actual coding bit rates of previous or previous few encoded segments.

To maintain consistent encoding quality for all pictures within a segment, the actual target bit rate for encoding the pictures is made variable according to their scene complexities as well as the target encoding quality of the segment.

As the target encoding quality of each segment is modified based on the differences between the target and the actual bit rates of previous or previous few encoded segments, the change of target encoding quality from segment to segment is made relatively smooth compared to that of a Constant Bit-Rate Encoder, and furthermore, the overall bit rate of encoding is maintained constant.

In accordance with an embodiment of the present invention, there is provided a method for use in a moving pictures encoder for encoding a sequence of segments each having at least one image, comprising the steps of:

a) determining an overall target bit rate for encoding the sequence of images;

b) determining a bit allocation and target quantisation step size for encoding a first segment on the basis of a segment target bit rate calculated using said overall target bit rate;

c) encoding said first segment using a variable bit rate encoding method according to the target quantisation step size;

d) determining a difference between the number of bits used to encode said first segment and said first segment bit allocation;

e) distributing said difference for use in encoding at least one subsequent segment to determine a subsequent segment bit allocation;

f) determining a new target quantisation step size for encoding a said subsequent segment on the basis of a new target segment bit rate calculated using said segment target bit rate and the distributed difference; and

g) encoding said subsequent segment using a variable bit rate encoding method according to the new target quantisation step size;

wherein variable bit rate encoding is employed for encoding pictures within a segment whilst maintaining a substantially constant bit rate over said sequence.

According to the current invention, a moving pictures sequence is divided into segments. The size of each segment may be suitably determined. Each segment is encoded with a target encoding quality derived from its target segment bit rate. A variable bit rate (VBR) encoder is utilised to encode the segment according to its target encoding quality.

The target segment bit rate of an initial segment is obtained from a user defined target overall bit rate. After encoding the segment, the difference between the actual bit rate used and the target segment bit rate is obtained. This difference is propagated to the next or next few segments to be coded. This process is repeated for each segment; therefore, for each subsequent segment, a new target segment bit rate is determined from the user defined target

overall bit rate and the differences between the target segment bit rates and actual bit rates of previous or previous few segments.

The present invention further provides an encoding quality adjustment processor for generating a target segment encoding quality value in a moving pictures encoder for encoding a series of segments each including a number of images using a variable bit rate encoding scheme whilst maintaining a substantially constant overall bit rate, comprising:

a bits difference computation means coupled to receive a segment encoding bit utilisation value and a target segment bit rate and generate therefrom a bits difference value representing a difference in bits allocated and bits used for encoding a segment;

a bits distribution means coupled to the bits difference computation means for computing at least one bits distribution value from the bits difference value and a predetermined distribution function for redistributing the difference in bits allocated and bits used for encoding a segment over a next k segments, where k is a positive integer;

a bit rate difference computation means coupled to the bits distribution means for computing a segment bit rate difference from the at least one bits distribution value and a predetermined number of images in a segment;

a target segment bit rate adjustment means coupled to the bit rate difference computation means and the bits difference computation means for computing said target segment bit rate from the segment bit rate difference and a predetermined target overall bit rate for the sequence of segments; and

an encoding quality computation means coupled to the target segment bit rate adjustment means for computing a target segment encoding quality value from said target segment bit rate.

The present invention further provides a moving pictures encoder comprising:

a coding processor for encoding picture data based on macroblocks according to a quantisation step size;

a virtual buffer processor coupled to the coding processor for tracking a number of bits used for encoding successive macroblocks in a picture and a number of bits used for encoding successive pictures in a group of pictures;

a quantisation step size processor coupled to the coding processor for determining said quantisation step size from a target number bits allocated for a picture and the number of bits already used for encoding macroblocks in that picture;

a picture bit allocation processor coupled to the quantisation step size processor for determining said target number of bits allocated for a picture from a target bit rate and the number of bits already used for encoding pictures in a current group of pictures;

a bit rate adjustment processor coupled to the picture bit allocation processor, the virtual buffer processor and the quantisation step size processor for determining said target bit rate from the number of bits already used for encoding successive pictures in the current group of pictures, a target encoding quantisation step size and an average quantisation step size for pictures in the current group of pictures; and

a target encoding quantisation step size processor coupled to the bit rate adjustment

Claims:

1. A method for controlling bit allocation in a moving pictures encoder for encoding a sequence of images comprising a plurality of segments each including a number of images, the method including:

a) determining an overall target bit rate for encoding the sequence of images; and for each segment in the sequence of images:

b) determining a difference of bits between a number of bits used for encoding at least one preceding segment and a number of bits allocated for encoding the at least one preceding segment;

c) calculating a bits distribution from the determined bits difference and a predetermined distribution function for redistributing said difference of bits over a next k segments, where k is a positive integer;

d) calculating a bit rate change from the bits distribution and a predetermined number of images in the segment;

e) calculating a target segment bit rate from the bit rate change and said overall target bit rate for the sequence of images; and

f) determining a target segment encoding quality from the target segment bit rate.

2. A method as claimed in claim 1, wherein each segment comprises at least one group of pictures having an I-picture and optionally at least one P and/or B-picture.

$$bits\_diff = \frac{segment\_BR \times N_{segment}}{picture\_rate} - bits\_segment$$

3. A method as claimed in claim 1 or 2, wherein the difference between the number of bits used for encoding the at least one preceding segment and the number of bits allocated for encoding the at least one preceding segment is determined according to:

where:

bits_diff	is said difference,
segment_BR	is the preceding segment(s) target bit rate,

$N_{segment}$ is the number of coded images in the previous segment(s), and

bits_segment is the actual number of bits used to encode the previous segment(s).

4. A method as claimed in claim 3, wherein the bits distribution is calculated according to:

$$delta\_bits_m = f(m) \times bits\_diff$$

where $delta\_bits_m$ is the number of bits difference allocated to next m^{th} segment in the sequence,

$m = 1,...,k$, and

$f(m)$ is a bit distribution function, where $\Sigma^k f(m) = 1$.

5. A method as claimed in claim 4, where $f(m) = 1/k$.

$$target\_Q = target\_Q' \left(1 + \frac{segment\_BR - segment\_BR'}{K \times segment\_BR'}\right)$$

6. A method as claimed in any one of claims 1 to 5, wherein the target segment encoding quality is calculated according to:

where *target_Q* is the target segment encoding quality,

segment_BR is the target segment bit rate,

target_Q' is the preceding segment target segment encoding quality,

segment_BR' is the preceding segment target segment bit rate, and

K is a constant.

7. A method for encoding moving pictures in a moving pictures encoder wherein a sequence of images are provided as input, the sequence of images comprising a plurality of segments each having a plurality of images, the method including:

determining target segment encoding quality for each segment in the sequence of images according to the bit allocation control method of any one of claims 1 to 6;

encoding the images in each segment according to the corresponding target segment encoding quality using a variable bit rate encoding technique taking into account scene complexities in the images in the segments.

8. An encoding quality adjustment processor for generating a target segment encoding quality value in a moving pictures encoder for encoding a series of segments each including a number of images using a variable bit rate encoding scheme whilst maintaining a substantially constant overall bit rate, comprising:

a bits difference computation means coupled to receive a segment encoding bit utilisation value and a target segment bit rate and generate therefrom a bits difference value representing a difference in bits allocated and bits used for encoding a segment;

a bits distribution means coupled to the bits difference computation means for computing at least one bits distribution value from the bits difference value and a predetermined distribution function for redistributing the difference in bits allocated and bits used for encoding a segment over a next k segments, where k is positive integer;

a bit rate difference computation means coupled to the bits distribution means for computing a segment bit rate difference from the at least one bits distribution value and a predetermined number of images in a segment;

a target segment bit rate adjustment means coupled to the bit rate difference computation means and the bits difference computation means for computing said target segment bit rate from the segment bit rate difference and a predetermined target overall bit rate for the sequence of segments; and

an encoding quality computation means coupled to the target segment bit rate adjustment means for computing a target segment encoding quality value from said target segment bit rate.

9. A moving pictures encoder comprising:

a coding processor for encoding picture data based on macroblocks according to a quantisation step size;

a virtual buffer processor coupled to the coding processor for tracking a number of bits used for encoding successive macroblocks in a picture and a number of bits used for encoding successive pictures in a group of pictures;

a quantisation step size processor coupled to the coding processor for determining said quantisation step size from a target number bits allocated for a picture and the number of bits

already used for encoding macroblocks in that picture;

a picture bit allocation processor coupled to the quantisation step size processor for determining said target number of bits allocated for a picture from a target bit rate and the number of bits already used for encoding pictures in a current group of pictures;

a bit rate adjustment processor coupled to the picture bit allocation processor, the virtual buffer processor and the quantisation step size processor for determining said target bit rate from the number of bits already used for encoding successive pictures in the current group of pictures, a target encoding quantisation step size and an average quantisation step size for pictures in the current group of pictures; and

a target encoding quantisation step size processor coupled to the bit rate adjustment processor and the virtual buffer processor for determining said target encoding quantisation step size from a predetermined target overall bit rate and the number of bits used for encoding a preceding group of pictures.